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Investigation of subtypes of hypertension and related factors in obese individuals

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Abstract

Both systolic and diastolic hypertension (HT) have been associated with insulin resistance. There are also studies showing a relationship between insulin resistance and systolic hypertension, but not with diastolic hypertension. This issue is controversial. In this study, we examined the relationship between hypertension subgroups and obesity and insulin resistance. Our study is retrospective and 391obese individuals were divided into 2 groups: normotension group and newly diagnosed hypertension group. The risk of HT in men was found to be 2.4 times higher than in women. The risk of HT was found to be 2.9 times higher in the group with insulin resistance. While there was a positive relationship between systolic blood pressure and CRP and HOMA-IR, no relationship was found with diastolic blood pressure. Metabolic inflammation and insulin resistance may be in the etiology of systolic HT rather than diastolic HT. Obesity-related hypertension is more common in men, with increasing age, and in those with insulin resistance. Systolic blood pressure may be associated with insulin resistance.

Keywords: obesity-related hypertension, systolic/diastolic hypertension, insulin resistance, metabolic inflammation

1. Introduction

Obesity is defined by excess body fat (adipose tissue) and is associated with a higher risk of developing serious diseases, including: type 2 diabetes, heart disease, and cancer.

The diagnosis of obesity is made by measuring people's weight and height and by calculating the body mass index (BMI): weight (kg)/height² (m²).

A BMI of 30 kg/m^2 to 34.9 kg/m^2 defines class 1 obesity, of between 35 kg/m^2 and 39.9 kg/m^2 constitutes class 2 obesity, and of at least 40 kg/m^2 marks class 3 obesity.

Waist circumferences (WC) of at least 102 cm in men and of at least 88 cm in women indicate abdominal obesity, which is associated with increased risk for adiposity-related disease (1, 2).

Define the degree of central adiposity based on waist-to-height ratio (WC/Height) as follows:

- Healthy central adiposity: waist-to-height ratio 0.4 to 0.49, indicating no increased health risks;
- Increased central adiposity: waist-to-height ratio 0.5 to 0.59, indicating increased health risks;
- High central adiposity: waist-to-height ratio 0.6 or more, indicating further increased health risks.

The health risks associated with higher levels of central adiposity include type 2 diabetes, hypertension and cardiovascular disease (3).

Insulin resistance refers to the reduced response of insulin-sensitive tissues to insulin signaling and is associated with the development of cardiovascular disease (4).

Insulin resistance occurring in obese individuals is explained by metabolic inflammation. This inflammation starts in the adipose tissue and causes insulin resistance by affecting the insulin receptor and intracellular pathways in the liver, muscle and fat tissue (5).

HOMA-IR (Homeostasis Model Assessment of Insulin Resistance) is an attractive screening tool for insulin resistance in clinical practice. The formula includes: fasting insulin (mU/L)*fasting glucose (mg/dl)/405. Values of HOMA-IR ≥ 2.5 are strongly correlating with the presence of IR (6).

According to the ESC 2023 Hypertension Guideline, the diagnosis of hypertension (HT) is defined as systolic 140 mm Hg and diastolic 90 mm Hg above the mean blood pressure in at least 2 measurements in 2 different examinations in the office. 140-159/90-99 mm Hg is rated as grade 1, 160-179/100-109 mm Hg as grade 2, and ≥180/100 mm Hg as grade 3. Isolated systolic hypertension is defined as diastolic blood pressure being <90 mm Hg when systolic blood pressure is ≥140 mm Hg, and isolated diastolic hypertension is defined as diastolic blood pressure being ≥90 mm Hg when systolic blood pressure is <140 mm Hg (7).

The relationship between weight gain and hypertension is known (8). The risk of hypertension in obese individuals was found to be 3.5 times higher than in non-obese individuals (9).

Excessive visceral fat distribution is accepted as the cause

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of hypertension in obesity. The mechanisms of obesity and obesity-related hypertension are due to the sympathetic nervous system, to renal and adrenal function, to the endothelium, to the adipokines, and to the insulin resistance (10).

It has been shown that systolic and diastolic hypertension increases as body mass index increases. However, there is also a metabolically healthy obese group and there is no risk of hypertension in this group (11). There are also studies showing that body mass index is more associated with isolated diastolic hypertension (12).

The relationship between insulin resistance and hypertension is also known (13). Additionally, the risk of developing hypertension was found to be high in those with insulin resistance (14). Both systolic and diastolic hypertension have been associated with insulin resistance (15). There are also studies showing a relationship between insulin resistance and systolic hypertension, but not with diastolic hypertension (16, 17).

In this study, we wanted to examine the relationship between systolic HT and diastolic HT, which are subtypes of hypertension, and insulin resistance-metabolic inflammation in obese individuals. We aimed to evaluate this issue, which has not yet been fully clarified, in our own patient population. We also investigated other factors that may affect obesity-related hypertension.

2. Materials and methods

Our study is retrospective, and 391 obese (Body mass index =BMI>30) individuals who applied to Kayseri City Hospital Internal Medicine and Obesity outpatient clinic between August 1, 2022 and April 1, 2024 were included in the study. They were divided into two groups: normotensive group and newly diagnosed hypertensive group.

The diagnosis of hypertension was made in at least two examinations and the average of at least two measurements was over 140 mm Hg systolic and 90 mm Hg diastolic. Patients with blood pressure averages below these values were considered as the normotensive group. Echocardiography was not performed because the patients had no cardiac complaints and their cardiological examinations and electrocardiography findings were normal.

Comparisons were made between the groups in terms of body mass index, waist circumference, liver and kidney function tests, insulin resistance levels, and blood lipids. In addition, subgroup analysis was performed by dividing groups with subtypes of hypertension, namely systolic hypertension, diastolic hypertension, and both systolic and diastolic hypertension.

Those with systolic blood pressure >140 mm Hg were considered systolic HT, those with diastolic blood pressure >90 mm Hg were considered diastolic HT, and those with systolic blood pressure >140 mm Hg and diastolic blood pressure >90 mm Hg were considered both systolic and diastolic hypertension. Blood pressure was classified as 140-159/90-99 mm Hg is rated as grade 1, 160-179/100-109 mm Hg as grade 2, and ≥180/100 mm Hg as grade 3.

Those with a HOMA-IR score ≥2.5 were considered to have insulin resistance.

Correlation analysis was performed for factors that may affect systolic blood pressure and diastolic blood pressure.

Inclusion criteria

- Obese individuals with a body mass index >30 who apply to the obesity clinic between the ages of 18-70.

Exclusion criteria

- Under age 18 and over 70;
- Pregnant women;
- Those taking anti-hypertensive medications;
- Those with chronic diseases (Diabetes, hypertension, cardiovascular disease);
- Those with HgA1c > 6.5;
- Those with a history of drug use;
- Patients with cardiac complaints and pathological findings on cardiac examination and electrocardiography.

Data obtained from patient file archive records were entered into the SPSS program.

In comparison of groups: Pearson Chi-Square test was used for nominal parameters. Independent samples T-test was used for parametric data, and Mann-Whitney U test was used for statistics of non-parametric data. Spearman test was applied for correlation analysis.

3. Results

391 patients with obesity were included in the study. Of these, 344 were women (88%) and 47 were men (12%). Newly diagnosed hypertension was detected in 93 (23.8%) patients included in the study. Systolic HT was detected in 58 (62.4%) patients, diastolic HT was detected in 14 patients (15%), and both systolic and diastolic HT were detected together in 21 (22.6%) patients. Stage 1 HT was detected in 77 (82.8%) patients, stage 2 HT was detected in 15 (16.1%) patients, and stage 3 HT was detected in 1 (1.1%) patient.

Age was significantly higher in the HT group. While 17 of the men (36.2%) had HT, 76 of the women (22.1%) had HT. The risk of HT in men was found to be 2 times higher than in women (p=0.033, odd ratio=1.998). There were 73 (18.7%) people with obesity but not insulin resistance, and 318 (81.3%) people with insulin resistance. The risk of HT was found to be 2.6 times higher in the group with insulin resistance (p=0.011, odd ratio=2.553).

Age, Body mass index (BMI), Waist circumference (WC),

Waist circumference/Height (WC/Ht), Glucose, Homeostatic Model Assessment for Insulin Resistance (HOMA-IR), Total Cholesterol (T. Chol), low-density lipoprotein (LDL), Triglyceride (TG), and CRP were found to be significantly higher and Glomerular filtration rate (GFR) was significantly lower in the hypertensive group compared to the normotensive group (Table 1).

Table 1. Comparison of the hypertensive and normotensive groups

Parameters		Hypertensive group, n=93	Normotensive group, n=298	*p*
Blood pressure means, (mm Hg)	**Systolic, mean±SD**	144.41±11.80	120.68±10.09	**0.000**
	Diastolic, mean±SD	83.69±11.16	69.67±8.81	**0.000**
Age, (years), Median (min-max)		38 (18-68)	34 (18-68)	**0.014**
Gender	**Female, n (%)**	76 (81.7%)	268 (89.9%)	**0.033**
	Male, n (%)	17 (18.3%)	30 (10.1%)	
Insulin resistance	**Pozitive, n (%)**	84 (90.3%)	234 (78.5%)	**0.011**
	Negative, n (%)	9 (9.7%)	64 (21.5%)	
BMI, (kg/m^2), Median (min-max)		38.4 (30-61)	36 (30-53)	**0.001**
WC, (cm), Median (min-max)		111 (85-177)	105 (84-198)	**0.000**
WC/Ht, Median (min-max)		0.68 (0.52-1.11)	0.65 (0.53-1.17)	**0.002**
Glucose, (mg/dL), Median (min-max)		93 (74-124)	90 (60-148)	**0.012**
HOMA-IR, Median (min-max)		3.95 (1.11-50.86)	3.22 (0.75-49.98)	**0.002**
HgA1c, (%), Median (min-max)		5.6 (4.7-6.3)	5.5 (4.7-6.4)	0.082
Creatinine, (mg/dL), Median (min-max)		0.69 (0.39-1.18)	0.68 (0.35-1.14)	0.197
GFR, (ml/min), Median (min-max)		111 (65-152)	113 (66-146)	**0.045**
AST, (U/L), Median (min-max)		18 (10-41)	17 (9-195)	0.304
ALT, (U/L), Median (min-max)		20 (7-53)	18 (6-251)	0.143
T. Chol, (mg/dL), Median (min-max)		194 (130-302)	183 (107-476)	**0.011**
LDL, (mg/dL), Median (min-max)		125 (75-213)	115 (42-386)	**0.004**
HDL, (mg/dL), Median (min-max)		46 (23-87)	47 (23-102)	0.230
TG, (mg/dL), Median (min-max)		139 (37-457)	118 (34-535)	**0.003**
CRP, (mg/L), Median (min-max)		5.2 (0.4-34)	4.3 (0.3-49.9)	**0.033**
TSH, (mU/L), Median (min-max)		2.1 (0.3-24.2)	2.1 (0.1-9.6)	0.787

Pearson Chi-Square test was used for nominal parameters. Independent samples T-test was used for parametric data, and Mann-Whitney U test test was used for statistics of non-parametric data. The significance level is P=0.05

SD=Standart deviation, BMI=Body mass index, WC=Waist circumference, WC/Ht= Waist circumference/Height, HgA1C=hemoglobin A1C, HOMA-IR=Homeostatic Model Assessment for Insulin Resistance, GFR= Glomerular filtration rate, AST=Aspartate transaminase , ALT= Alanine transaminase, T.Col = Total Cholesterol , LDL=low-density lipoprotein , HDL=High-density lipoprotein , TG=Triglyceride , CRP= C-Reactive Protein, TSH=Thyroid stimulating hormone

In the correlation study, a positive correlation was found between systolic and diastolic blood pressure and age, glucose, BMI, HgA1c, WC, WC/Ht ratio, T. Chol and LDL; while a negative correlation was found between GFR. While there was a positive relationship between systolic blood pressure and CRP, HOMA-IR and creatine, no relationship was found with diastolic blood pressure. While there was a positive relationship between diastolic blood pressure and TG, no relationship was found with systolic blood pressure (Table 2).

Table 2. Correlation results of factors related to systolic and diastolic blood pressure

Paramaters	Systolic blood pressure		Diastolic blood pressure	
	Correlation Coefficient	*p*	Correlation Coefficient	*p*
Age	0.134	**0.008**	0.109	**0.030**
Glucose	0.183	**0.000**	0.141	**0.006**
BMI	0.224	**0.000**	0.173	**0.001**
HOMA-IR	0.172	**0.001**	0.077	0.136
HgA1c	0.175	**0.001**	0.112	**0.027**
WC	0.240	**0.000**	0.227	**0.000**
Creatine	0.103	**0.044**	0.078	0.128
GFR	-0.150	**0.003**	-0.140	**0.006**
Total Cholesterol	0.121	**0.018**	0.125	**0.014**
LDL	0.160	**0.002**	0.130	**0.011**
TG	0.092	0.073	0.108	**0.035**
CRP	0.121	**0.020**	0.009	0.867
WC/Ht	0.222	**0.000**	0.194	**0.000**

Spearman's test
Correlation is significant at the 0.05 level. BMI=Body mass index, WC=Waist circumference, WC/Ht= Waist circumference/Height, HOMA-IR=Homeostatic Model Assessment for Insulin Resistance , HgA1C=hemoglobin A1C, GFR= Glomerular filtration rate, T.Col = Total Cholesterol , LDL=low-density lipoprotein, TG=Triglyceride, CRP= C-Reactive Protein

4. Discussion

In our study, HT was detected in 23.8% of the patients. We found that the risk of HT in men is 2 times higher than in women. Age was significantly higher in the HT group. The risk of HT was 2.6 times higher in the group with insulin resistance. BMI, WC, WC/Ht, Glucose, HOMA-IR, T. Chol, LDL, TG, and CRP were found to be significantly higher; GFR was significantly lower in the hypertensive group compared to the normotensive group. While there was a positive relationship between systolic blood pressure and CRP, HOMA-IR, no relationship was found with diastolic blood pressure.

It is known that the risk of hypertension increases as age increases. In our study, the older age in the hypertensive group is compatible with the literature (18).

It is known that male gender is an independent risk factor for HT (11). Although there is a study (13) that found that HT in obese individuals is 2 times more common in women, in our study we found it to be 2.4 times more common in men.

Although there was a study (13) that found BMI to be associated with isolated diastolic hypertension, we found it to be associated with both systolic and diastolic hypertension.

In previous studies, isolated systolic hypertension was found to be higher up to the 6th decade (13). We found a positive correlation between age and both systolic and diastolic hypertension, consistent with the literature.

BMI, WC, WC/Ht, Glucose, HOMA-IR, T. Chol, LDL, TG, and CRP were significantly higher in the hypertensive group than in the normotensive group, indicating that hypertensive-obese individuals have more abdominal fat, insulin resistance, metabolic inflammation and shows that they are prone to atherosclerosis.

The finding of a significant relationship between systolic and diastolic blood pressure and male gender, age, BMI, T. Chol, LDL, TG levels was found to be similar to the literature (14). Differently, we found a significant relationship between HOMA-IR and systolic blood pressure, but not diastolic. It has also been found to be associated with diastolic blood pressure in the literature (14). The reason for this is that systolic HT is mostly due to vascular resistance secondary to atherosclerosis, while diastolic HT may be due to volume increase, sympathetic nervous system activation, and impaired renal salt excretion. The lower carotid intima media thickness in isolated diastolic hypertensive patients compared to patients with isolated systolic HT and systolic+diastolic HT supports our idea (20).

Obesity-associated inflammation is a systemic process that affects all metabolic organs (21). While there is a relationship between CRP and systolic blood pressure, there is no relationship with diastolic blood pressure, suggesting that metabolic inflammation may be the cause of the etiology of systolic hypertension.

Isolated diastolic HT also increases the risk of cardiovascular events, like isolated systolic HT. It has been shown that the development of cardiovascular events decreases with isolated diastolic HT treatment (22).

New studies are needed to elucidate the etiology of isolated diastolic HT and to develop treatment appropriate to the etiology.

The limitations of our study are that it is retrospective and the number of patients is small.

Obesity-related hypertension is more common in men, with increasing age, and in those with insulin resistance. We found a relationship between insulin resistance and systolic HT.

Ethical Statement

Ethics committee approval for the study was received from Kayseri City Hospital Non-Interventional Clinical Research Ethics Committee with date 07.05.2024 and decision number

77.

Conflict of interest

The authors declare no conflict of interest.

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None to declare.

Authors' contributions

Concept: S.B., Design: S.B., Data Collection or Processing: S.B., B.A., Analysis or Interpretation: S.B., Literature Search: S.B., B.A., Writing: B.A.

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